

U.S. Patent Application Serial No. 09/446,958  
Reply to Office Action dated March 30, 2005

**Amendments to the Claims:**

This listing of claims will replace all prior versions and listing of claims in the application.

Claims 1, 5-8, 10, and 17 are amended.

**Listing of Claims:**

1. (Currently Amended) A method for the modulating of a multicarrier signal with a density  $1/(v_0 \tau_0) = 2$ , formed by successive symbols, each comprising  $M$  samples to be transmitted and constituted by a set of  $2M$  orthogonal carrier frequencies in the real sense, the interval between two neighboring carrier frequencies being equal to  $v_0$  and the interval between the times of transmission of two consecutive symbols, or the symbol time, being equal to  $\tau_0$ , each of said carrier frequencies being modulated according to one and the same modulation prototype function  $g(t)$  with a truncation length of  $2L\tau_0$ ,  $L$  being an integer representative of said truncation length, comprising, at each symbol time, the following steps:
- obtaining a set of  $2M$  complex coefficients representing data to be transmitted;
  - computing  $2LM$  linear combinations from said  $2M$  complex coefficients obtained, said combinations using weighting coefficients representing said prototype function  $g(t)$ , so as to obtain  $2LM$  coefficients;
  - summing said  $2LM$  coefficients weighted in predetermined storage locations of a memory comprising  $2LM$  storage locations representing  $2L$  groups of  $M$  distinct partial sums, so as to gradually form, in said  $2LM$  storage locations, over a duration of  $2L\tau_0$ ,  $M$  samples to be transmitted; and
  - transmitting said samples to be transmitted.

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2. (Previously Presented) Method of modulation according to claim 1, wherein a sample to be transmitted at the instant  $j\tau_0 + k\tau_0/M$ , referenced  $s_{k+jM}$  is written as follows:

$$s_{k+jM} = \sum_{q=0}^{2L-1} [\alpha_{k,q} C_{k,j-q} + \beta_{k,q} C_{k+M,j-q}]$$

where:  $C_{0,j}$  to  $C_{2M-1,j}$  are the  $2M$  complex coefficients generated between the instants  $j\tau_0$  and  $(j+1)\tau_0$ ;

$\alpha_{k,q}$  and  $\beta_{k,q}$  are said weighting coefficients.

3. (Original) Method of modulation according to claim 2, characterized in that:

- $\alpha_{k,q} = 0$  for  $q$  as an odd parity number;
- $\beta_{k,q} = 0$  for  $q$  as an even parity number.

4. (Previously Presented) Method of modulation according to claim 3, comprising, for a generation of a symbol with an index  $j$  formed by  $M$  samples, the following steps:

- obtaining  $2M$  real inputs  $a_{m,j}$  representing a source signal;
- pre-modulating of each said real inputs producing  $2M$  complex coefficients;
- reverse Fourier transforming said  $2M$  complex coefficients producing  $2M$  complex transformed coefficients  $C_{0,j}$  to  $C_{2M-1,j}$ ;
- for each of the  $M$  pairs  $(C_{k,j}, C_{(k+M),j})$  of said transformed coefficients, computing  $2L$  weighted coefficients, the weighing coefficients representing said prototype function;
- summing the result of each of said weighted  $2LM$  values to the contents of the  $2LM$  distinct memory zones so as to gradually build the samples to be transmitted constituting the symbols  $j, (j+1), (j+2), \dots, (j+2L-1)$ ; and
- sending  $M$  samples corresponding to the  $M$  oldest contents of said memory zones and

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then resetting the contents of said M memory zones.

5. (Currently Amended) Method of modulation according ~~any of the claims 1 to 4~~ to claim 1, wherein said steps are implemented at the rate  $\tau_0/M$  of the samples.

6. (Currently Amended) Method of modulation according to ~~any of the claims 1 to 5~~ claim 1, wherein said transmission step is followed by a step for updating said memory locations comprising:

- physical shifting of the contents of each of said memory locations if the latter ~~are~~ memory contains elements of a shift register; or
- updating the write and read addresses of said memory locations, if the latter ~~are~~ memory contains elements of a RAM.

7. (Currently Amended) Method of modulation according to ~~any of the claims 1 to 6~~ claim 1, wherein said 2M complex coefficients representing data elements to be transmitted are obtained by the implementation of a mathematical transform comprising the following steps:

- applying a real reverse Fourier transform;
- ~~[[the]]~~ circular ~~permutation~~ permutating of the result of this reverse transform by M/2 coefficients leftwards; and
- multiplying of each of said coefficients by  $i^n$ .

8. (Currently Amended) Method of modulation according to ~~any of the claims 1 to 7~~ claim 1, wherein the signal centered on the frequency  $M\nu_0$  is written as follows:

$$s(t) = \sum_n \sum_{m=0}^{2M-1} a_{m,n} (-1)^{m(n+L)} i^{m+n} e^{2i\pi m\nu_0 t} g(t - n\tau_0)$$

9. (Previously Presented) A device for modulating of a multicarrier signal with a density

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$1/(v_0 \cdot \tau_0) = 2$ , formed by successive symbols, each comprising  $M$  samples to be transmitted and constituted by a set of  $2M$  orthogonal carrier frequencies in the real sense, the interval between two neighboring carrier frequencies being equal to  $v_0$  and the interval between the times of transmission of two consecutive symbols, or symbol time, being equal to  $\tau_0$ , each of said carrier frequencies being modulated according to one and the same modulation prototype function  $g(t)$  with a truncation length of  $2L\tau_0$ , said device for modulating comprising:

- means for temporary storage of  $2M$  groups of  $M$  partial sums in temporary storage locations;

- means for weighting  $2M$  complex coefficients representing data elements to be transmitted by weighting coefficients representing said prototype function  $g(t)$ ; and

- means for summing the weighted coefficients in respective predetermined memory locations of said temporary storage locations,

so as to gradually form said samples to be transmitted on a duration of  $2L\tau_0$ .

10. (Currently Amended) A device for modulating according to claim 9, ~~characterized in that it comprises~~ further comprising:

- means of mathematical transformation delivering said  $2M$  complex coefficients representing data elements to be transmitted at the rate  $\tau_0/2M$  and in the following order  $(C_{n,j}, C_{M+1,j}, \dots, C_{M-1,j}, C_{2M-1,j})$ ;

- storage means including  $2LM-M$  simultaneous read/write RAM type memory locations;

and

- $N$  complex multipliers working at the rate  $N\tau_0/2LM$ ,  $N$  being equal to 1, 2, 4, ... or  $2L$ .

11. (Previously Presented) A method for demodulating a received signal corresponding to a transmitted multicarrier signal with a density  $1/(v_0 \cdot \tau_0) = 2$ , formed by successive symbols, each comprising  $M$  samples to be transmitted and constituted by a set of  $2M$  orthogonal carrier

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frequencies in the real sense, the interval between two neighboring carrier frequencies being equal to  $\nu_0$  and the interval between the times of transmission of two consecutive symbols, or symbol time, being equal to  $\tau_0$ , each of said carrier frequencies being modulated according to one and the same modulation prototype function  $g(t)$  with a truncation length of  $2L\tau_0$ , wherein an estimation of  $2M$  real data elements transmitted at a given symbol time is reconstituted by means of the following steps:

- sampling said signal received at the sample frequency  $\tau_0/M$ , delivering  $M$  complex samples received;
- storing each of said  $M$  complex samples received in a predetermined location of an input memory comprising  $2ML$  complex locations, in which there have been previously memorized  $(2L-1)M$  samples received during the  $2L-1$  previous symbol times;
- multiplying the  $2ML$  values contained in said input memory by coefficients representing said prototype function;
- temporal aliasing, by summing up  $2M$  series of  $L$  results of the multiplication step, so as to obtain  $2M$  complex values; and
- processing said  $2M$  complex values to form said estimations of the  $2M$  real data elements transmitted.

12. (Previously Presented) Method for demodulating according to claim 11, wherein  $2M$  complex values derived from the temporal aliasing step between the instants  $(j+2L-1)\tau_0$  and  $(j+2L)\tau_0$  are written as follows:

$$R_{k,j} = \sum_{q=0}^{2L-1} \alpha'_{k,q} r_{k,(j+q)M}$$

$$R_{k+M,j} = \sum_{q=0}^{2L-1} \beta'_{k,q} r_{k,(j+q)M}$$

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where:

$r_{k+(j+q')M}$  represents the sample received at the instant  $k'\tau_0+(j+q')\tau_0/M$ ;

$\alpha'_{k,q}$  and  $\beta'_{k,q}$  are said weighting coefficients.

13. (Previously Presented) Method for demodulating according to claim 11, wherein:

- $\alpha'_{k,q} = 0$  for  $q'$  as an odd parity value;
- $\beta'_{k,q} = 0$  for  $q'$  as an even parity value.

14. (Previously Presented) Method for demodulating according claim 11, wherein said processing step comprises the following steps:

- applying a mathematical transformation that is the reverse of the one performed during the modulation on said  $2M$  complex values delivering  $2M$  transformed values;
- correcting phase and/or amplitude distortions due to the transmission channel; and
- extracting the real part of said transformed complex values.

15. (Previously Presented) Method for demodulating according to claim 11, wherein said steps are implemented at the rate  $\tau_0/M$  of the samples.

16. (Previously Presented) Device for demodulating a received signal corresponding to a transmitted multicarrier signal with a density  $1/(v_0\tau_0)=2$ , formed by successive symbols, each comprising  $M$  samples to be transmitted and constituted by a set of  $2M$  orthogonal carrier frequencies in the real sense, the interval between two neighboring carrier frequencies being equal to  $v_0$  and the interval between the times of transmission of two consecutive symbols, or symbol time, being equal to  $\tau_0$ , each of said carrier frequencies being modulated according to one and the same modulation prototype function  $g(t)$  with a truncation length of  $2L\tau_0$ , said device for demodulating comprising:

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- means for sampling said received signal;
- means for temporary storage of the complex samples comprising 2ML complex locations;
- means for multiplying said complex samples by weighting coefficients representing said prototype function;
- temporal aliasing means summing up L weighting results so as to obtain 2M complex values; and
- means for processing said complex values delivering an estimation of 2M real data elements transmitted at each symbol time.

17. (Currently Amended) A device for demodulating according to claim 16, characterized in ~~that it comprises~~ further comprising:

- means of mathematical transformation that is the reverse of the transformation performed during the modulation on said 2M complex values;
- means for correction of phase and/or amplitude distortions due to the transmission channel; and
- means for extracting the real part of said transformed complex values.

18. (Previously Presented) A device for demodulating according to any of the claims 16 and 17, comprising:

- storage means comprising 2ML-M simultaneous write/read RAM type complex memory locations;
- N complex multipliers working at the  $N\tau_0/2LM$  rate, where N is equal to 1, 2, 4 ... or 2L; and
- means of mathematical transformation working at the  $\tau_0/2M$  rate, whose inputs  $R_{0j}$  to  $R_{2M-1,j}$  are read in the order  $(R_{0j}, R_{Mj}), (R_{1j}, R_{M+1j}), \dots (R_{M-1j}, R_{2M-1j})$ .

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19. (Previously Presented) A filtering method delivering series of M complex output values at regular intervals from 2L series of 2M complex input values, said M complex values corresponding to a weighted sum of 2L of said complex input values to be processed, said filtering method comprising the following steps for each series of complex input values:

- computing 2LM linear combinations from said 2M complex input values obtained, the weighting coefficients being derived from 2L complex or real filters with a size M, so as to obtain 2ML values;

- summing each of the 2ML values in a predetermined memory location out of a set of 2ML memory locations each containing a partial sum so as to gradually form said output values in said 2ML memory locations on a period corresponding to the reception of 2L series of complex input values.